JHR 48: 95–99 (2016)
doi: 10.3897/JHR.48.7905
http://jhr.pensoft.net

SHORT COMMUNICATIONS

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

Case series of 23 deaths from Hymenoptera stings among United States Air Force populations

Jameson D. Voss[1], Richard Kugblenu[2], Khabira Salter[3], Lucas Johnson[4], Will K. Reeves[1,5]

1 *United States Air Force School of Aerospace Medicine, PHR, 2510 5th Street, Wright-Patterson AFB, OH 45433, USA* **2** *Oak Ridge Institute for Science and Education, Wright-Patterson AFB, OH 45433, USA* **3** *Decypher, Wright-Patterson AFB, OH 45433, USA* **4** *Uniformed Services University of the Health Sciences, Department of Preventive Medicine and Biometrics, Washington D.C. 20814, USA* **5** *2510 Fifth Street, Building 840, Wright-Patterson AFB, OH 45433, USA*

Corresponding author: *Will K. Reeves* (will.reeves@us.af.mil)

Academic editor: *Jack Neff* | Received 25 January 2016 | Accepted 18 February2016 | Published 1 March 2016

http://zoobank.org/A31F8C69-FDED-450C-8FC6-3F974D0CDE70

Citation: Voss JD, Kugblenu R, Salter K, Johnson L, Reeves WK (2016) Case series of 23 deaths from Hymenoptera stings among United States Air Force populations. Journal of Hymenoptera Research 48: 95–99. doi: 10.3897/JHR.48.7905

Abstract

Medical conditions arising from hymenopteran sting allergy or mass envenomation are a serious health concern, particularly in austere environments. Both practicing allergists and entomological pest control personnel should consider the relevance of stinging insects when responding to problems with Hymenoptera. Recent occupational reviews of civilian deaths from insect bites and stings prompted our review of the US Air Force Mortality Registry to determine the relevance of insect stings and bites as a cause of death in the US Air Force. After reviewing over 40 years of death records we identified 23 death records, among US Air Force Active duty, guard, or retirees that arose directly from hymenopteran stings.

Keywords

Hymenoptera, bees, wasps, stings, mortality, military, Air Force Mortality Registry

Copyright *Jameson D. Voss et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Introduction

Public health aspects of pest control have substantially improved since the days when flea-infested rats helped transmit the Black Death that decimated medieval Europe (Tulchinsky and Varavikova 2014). Advancements in military medicine are also striking; vector-borne diseases such as malaria were once shaping military battles, but are now manageable with integrated pest control pioneered by the military (Ockenhouse et al. 2005). In the early 1900s, then Colonel (later General) William Gorgas virtually eliminated malaria and yellow fever at the Panama Canal Zone using a combination of vector control, medical prophylaxis, screens around living quarters, and other measures (Ockenhouse et al. 2005). Similarly, the discipline needed to ensure compliance with medical countermeasures for zoological or entomological diseases has also been a mainstay in the military approach to these threats. More recently, a soldier's death from rabies called to mind the public health role of command-directed interventions to protect the health of military members (Chretien 2012).

In modern times, this legacy of fleas, mosquitoes, and stray dog control makes it easy to overlook another threat envenomation from Hymenoptera (i.e., bees, wasps, and ants) or possibly other insects such as certain Lepidopteran caterpillars. While hymenopteran stings are known to cause allergic reactions, their medical importance is underestimated because their venom is often more irritating than lethal and they are not known as a vector for any infectious diseases.

Despite having a lower historical priority, there is growing evidence for the medical importance of ants, bees, and wasps. A recent review of mortality among workers in the United States found there were 52 occupational deaths from bees, 11 deaths from wasp stings, 4 from ant stings, and an additional 16 from spiders or other unknown insects from 2003–2010 and thousands of non-fatal lost work days attributable to insect stings (Pegula and Kato 2014). Less is known about mortality among military populations, but from a morbidity perspective, Hymenoptera were recently identified as an environmental threat to deployed military personnel throughout the world (Turbyville et al. 2013). This conclusion was based on the presence of medically important Hymenoptera species in Afghanistan and surrounding areas and a review of medical records in the deployed environment showing 1 in every 500 medical encounters was attributable to insect stings (Turbyville et al. 2013).

Methods

We evaluated the Air Force Mortality Registry (AFMR), which is the largest mortality registry within the Department of Defense. In the late 1990s, the Air Force began to compile death records from any member who died in the Active, Reserve, and Guard components of the Air Force and any retiree from these components. These records are still being collected from current times and now date back to 1970. There are over

350,000 deaths already registered within this database. The Air Force is the only service to assemble a long-term database of mortality records among retirees.

Within AFMR, deaths are classified by International Classification of Diseases (ICD) –10 codes based on the death certificate, casualty reports, ICD–10 codes obtained from the National Death Index, or a combination of sources. We defined cases as those having an ICD–10 of T63.4, which is the standardized coded designation for hymenoptera stings. All death certificates were reviewed individually to evaluate whether the individual died at home, on arrival, or after arrival to a medical facility.

Results and discussion

There were 23 deaths due to Hymenoptera stings representing <0.7 per 10,000 of all registered deaths within AFMR. A death certificate was available for 15 of the 23 identified cases. The number of stings was not reported so we could not determine if these were death from a single sting or mass envenomation. There is a significant difference between death from anaphylaxis or heart attack and massive toxin exposure. Eight individuals died after arrival to the emergency room, but before admission to an inpatient setting, and three died after being admitted to an inpatient setting. Thus, 11/15 deaths (73%) occurred after arrival to an emergency department.

Aggregate demographics are provided in Table 1. With less than one documented Hymenoptera sting death per year, these deaths are undoubtedly rare. In fact there were only three deaths in active personnel instead of retirees. This indicates that even with the higher risk jobs found in the military deaths from Hymenoptera stings are extremely rare despite the relatively common sting related medical encounters reported by Turbyville et al. (2013). This could be the result of military policy that excludes uniformed service in individuals with known anaphylactic allergies to insect bites or stings. Nevertheless, Hymenoptera sting deaths are more common in AFMR than other highly emphasized rare causes of death such as rabies and malaria (ICD–10s A82, Z20.3, and B50–B54; see Reeves and Bettano 2014), which could indicate that prior service increases the risk or exposure to Hymenoptera and thus allergic reactions later in life. When taken in the context of the overall US at work population a recent review by Pegula and Kato (2014) reported an average of 10 fatal injuries resulting from insects per year from 2003-2010 in the USA. In this regard while sting related deaths were rare among the USAF and retirees they are a potentially significant por-

Table 1. Summary Characteristics of 23 Hymenoptera Death Cases in the US Air Force 1977–2013.

Age	average 59.0; range 38–86
Sex	22 males; 1 female
Status	20 retirees; 1 each from Active, Reserve, and Guard components

tion of the annual US deaths from Hymenopteran stings. Since the Army, Navy, and Marines Corps. do not have a similar mortality registry it is not currently possible to determine if their death rates were higher.

Clinical allergists could potentially play a role in secondary prevention of death or serious allergic reactions, such as screening individuals at risk for Hymenoptera sensitivity including at the time of retirement or separation from military service. Once identified, these individuals could carry medical countermeasures as recommended by their medical provider. Immunologic testing (e.g., specific IgE tests, basophil activation test, horseradish peroxidase, etc.) may help with identification and immunotherapy may provide therapeutic and quality of life benefits (Boyle et al. 2012, Eberlein et al. 2012). An even more intriguing observation for clinical allergists is that the majority of cases (73%) in this series of deaths were alive at the time they arrived for medical care. Most anaphylactic deaths take more than an hour after initial exposure. While we are not certain that improved medical care would have prevented any of the deaths, the death certificates clearly indicate that deaths rarely occur immediately after the sting without time for advanced medical treatment.

Conclusion

While a comprehensive approach to Hymenoptera control offers hope that these deaths are modifiable, these benefits have not yet materialized. In fact, despite the broad-based progress in mitigating medical effects of numerous pests, trends in occupational Hymenoptera deaths are fairly stable over the past decade (Pegula and Kato 2014). The unique challenges in mitigating medical consequences of Hymenoptera mark another opportunity for a public health approach.

Acknowledgements

The authors have no conflicts of interest to disclose. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Uniformed Services University, United States Air Force, United States Navy, Department of Defense, or the U.S. Government. Distribution A: Approved for public release; distribution is unlimited. Case Number: 88ABW–2015-1032, 11 March 2015.

References

Boyle RJ, Elremeli M, Hockenhull J, Cherry MG, Bulsara MK, Daniels M, Elberink JNO (2012) Venom immunotherapy for preventing allergic reactions to insect stings. Cochrane Database of Systematic Reviews 10: CD008838. doi: 10.1002/14651858.cd008838.pub2

Chretien JP (2012) Protecting service members in war--non-battle morbidity and command responsibility. New England Journal of Medicine 366: 677–679. doi: 10.1056/NEJMp1112981

Eberlein B, Krischan L, Darsow U, Ollert M, Ring J (2012) Double positivity to bee and wasp venom: improved diagnostic procedure by recombinant allergen-based IgE testing and basophil activation test including data about cross-reactive carbohydrate determinants. Journal of Allergy and Clinical Immunology 130: 155–161. doi: 10.1016/j.jaci.2012.02.008

Ockenhouse CF, Magill A, Smith D, Milhous W (2005) History of U.S. military contributions to the study of malaria. Military Medicine 170: 12–16. doi: 10.7205/MILMED.170.4S.12

Pegula S, Kato A (2014) Fatal injuries and nonfatal occupational injuries and illnesses involving insects, arachnids, and mites. Beyond the Numbers 3(17). Available at: http://www.bls.gov/opub/btn/volume-3/fatal-injuries-and-nonfatal-occupational-injuries-and-illnesses-involving-insects-arachnids-and-mites.htm [accessed January 5, 2015]

Reeves WK, Bettano AL (2014) A review of mortality from parasitic and vector-borne diseases in the U.S. Air Force from 1970 to 2012. Journal of Parasitology 100: 189–192. doi: 10.1645/13-396.1

Tulchinsky TH, Varavikova EA (2014) The new public health, 3rd ed. Academic Press, London.

Turbyville JC, Dunford JC, Nelson MR (2013) Hymenoptera of Afghanistan and the central command area of operations: assessing the threat to deployed U.S. service members with insect venom hypersensitivity. Allergy and Asthma 34: 179–184. doi: 10.2500/aap.2013.34.3638